25 November 2002 **Inmarsat Ventures plc**
IB Docket 01-185

ECONOMIC IMPACT OF TERRESTRIAL L-BAND SERVICES ON INMARSAT AND ITS USERS

Background

- Terrestrial uses of the L-band ("ATC") would cause two types of interference into the Inmarsat system: (i) interference into the Inmarsat spacecraft, and (ii) interference into Inmarsat mobile terminals
    - ATC interference would adversely affect Inmarsat operations both within the United States, as well as in other parts of the world

- Trying to accommodate ATC in the L-band by setting technical limits on ATC operations in the United States will not resolve these interference problems, but in fact would constrain the continued development of even more efficient L-band satellite networks

- This paper outlines the economic impact on Inmarsat and its users of allowing ATC to operate in the L-band, primarily taking into account the impact on the next-generation Inmarsat-4 spacecraft design

    - The new Inmarsat-4 spacecraft design will be used to replace Inmarsat 3 at 54º W.L. in early 2004. The new Inmarsat-4 network, being implemented at a cost of over $1.6 billion, is a state-of-the-art system, with satellites employing greater frequency reuse, smaller spot beams, and higher power capabilities than ever before

        - The Inmarsat-4 design resolves some of the technical constraints that previously limited the spectrum available on Inmarsat-3
        - Inmarsat-4 can share, on a co-channel basis, every MHz of L-band spectrum that MSV currently is authorized to use on its spacecraft

Economic Effect on Inmarsat Outside the US

- Co-channel interference from ATC is the most serious and unmanageable interference threat to Inmarsat spacecraft. In parts of the world outside North America, Inmarsat will continue to reuse, on a co-channel basis, the same parts of the L-band that MSV uses to serve North America. Thus, co-channel interference from ATC threatens Inmarsat satellite communications outside the United States

- Co-channel ATC interference into Inmarsat spacecraft would:

    - degrade the quality of service to Inmarsat users outside the US
    - constrain the MSS spectrum available for Inmarsat service outside the US
    - reduce the overall capacity of the Inmarsat system

- Thus, ATC use within the US threatens to reduce the revenue that Inmarsat expects to continue to generate from service outside the US

- Emissions from MSV's ATC mobile transmitters in the L-band would cause interference to co-channel transmissions on spot beams on the Atlantic Ocean Region (AOR) Inmarsat-4 spacecraft at 54º W.L. This would affect those spot beams where Inmarsat otherwise could reuse spectrum outside of North America (in the absence of ATC), i.e. the North Atlantic ocean area and Latin America. As Inmarsat has previously demonstrated this would affect at least 30% of the Inmarsat-4 AOR spot beams. ATC interference similarly would constrain Inmarsat service from its Pacific Ocean Region (POR) orbital location, especially in the North Pacific ocean area

    - Inmarsat expects to be able to reuse on Inmarsat-4 any uplink spectrum currently assigned to MSV to provide MSS to North America

- The impact would be greater if other companies also implemented terrestrial services in the L-band, or if we accounted for the loss of the additional bandwidth that MSV would need to avoid self-interference from ATC into its own satellite operations

Economic Impact on Inmarsat Inside the US

- ATC deployment would reduce Inmarsat's ability to serve the entire United States telecommunications market

- By effectively limiting access to the US market, terrestrial uses of the L-band could substantially reduce a significant new source of revenue for Inmarsat
- Thus, terrestrial uses of the L-band could reduce the attractiveness of Inmarsat to new investors, such as those new investors needed to achieve substantial dilution in the IPO mandated by the ORBIT Act

- ATC interference into mobile earth terminals would prevent Inmarsat terminals from operating in the vicinity of ATC base stations (i.e., would create "exclusion zones")

    - Power levels emitted by ATC base stations would overwhelm mobile Inmarsat earth terminals optimized to receive low-level satellite signals from 22,300 miles away

- These "exclusion zones" would preclude Inmarsat from providing service anywhere in the US near an ATC base station, and along a path where a clear line-of-sight exists toward the ATC base station

    - this easily could be 20 miles or more away from the base station in the case of Inmarsat aeronautical terminals

    - exclusion zones would disrupt existing Inmarsat services in the US

- maritime services (including tracking and reporting of cargo containers) provided to Government and commercial ships in US waters, including approaches to and within ports, rivers, waterways, and coastal areas
    - these services are used for homeland security, and will be essential to supporting implementation of the recently-passed Maritime Transportation Security Act of 2002, which is awaiting the President's signature
- aeronautical services provided to Air Force 1 and 2, the FAA, and all other users of Inmarsat aeronautical services, including the major international airlines and most corporate aircraft ('bisjets')
    - Airlines, corporate jets and government aircraft use Inmarsat for a variety of purposes, including general communications and providing weather updates and flight routing information to flights in progress
    - FAA relies on Inmarsat services for air traffic control communications in all oceanic air space (12 miles or more from a coast) allotted to the US by the International Civil Aviation Organization (ICAO)
- land mobile, including tracking of sensitive cargoes

- ATC "exclusion zones" would create "Swiss cheese" holes in Inmarsat's service area within the US
    - Cutting up its service area would limit Inmarsat's ability to successfully deploy new services throughout the US
        - land mobile services, such as high speed data for video and audio transmissions by journalists, and cargo tracking via micro terminals such as Inmarsat-miniC and D+
        - Inmarsat-4 BGAN services will provide new broadband capacity to many areas of the US well in advance of terrestrial rollout of next generation mobile services, both in urban and rural regions
        - innovative aeronautical services that could be used on approaches to US airports.
- It is also possible that ATC base-station emissions would interfere with GPS navigation, since the GPS band lies above the upper edge of the Mobile Satellite Service downlink band

Economic impact of ATC limits

- Technical limits that might be considered to mitigate the uplink interference from ATC are not feasible to implement because:
    - It is not practical to accurately measure in space, identify the source of, and control, the aggregate noise from large numbers of ATC terrestrial handsets in different geographic areas that threaten Inmarsat spacecraft operations
        - this would require a means to measure and identify the source and location of that interference at the Inmarsat spacecraft, and transmit that information to a ground facility that could immediately control the operation of the ATC network, and reduce the level of aggregate emissions
        - designing and implementing such a system would be very challenging as a technical matter
            - this is particularly true in the case of ATC, with a dynamic interference environment consisting of hundreds of thousands of simultaneously occurring transmissions, and changing signal propagation and fading conditions caused by user mobility
        - Inmarsat does not currently have such a capability on its satellites, and doubts that it is feasible to design and implement such a system
        - nor is it clear how the terrestrial network would be designed to effectuate such limits and to cease causing interference upon notice from Inmarsat
            - terrestrial control system would need to support the immediate control and cessation of aggregate emissions from large numbers of terrestrial handsets
- Even if it were possible to overcome these technical challenges and design an uplink interference monitoring and control system that was practically implementable, the measurements would have to be made at the orbital location of the spacecraft receiving interference
    - implementing such a system on Inmarsat-4 would impose large costs on Inmarsat
        - the Inmarsat-4 spacecraft now being built for 54 W.L is at a very advanced stage of construction
            - the payload is now in the final stages of integration
        - changing the system design at this late date would delay its late ‘03/early’04 scheduled launch
        - resulting program delays would
            - impose large costs, potentially ranging in the 10s of millions of dollars

- reduce the value of the income stream Inmarsat expects to generate from Inmarsat-4 operations
- delay the provision of broadband MSS service to the US

- moreover, adding this feature to the spacecraft at this late date would add an unknown cost to the Inmarsat-4 program and could generally open up to renegotiation the spacecraft contract

- the negligible remaining power and mass margins on the Inmarsat-4 bus would not likely support this feature in any event
- moreover, such a change would add commercially unacceptably new levels of technology risk

- Any ATC limits based on the current design of the Inmarsat-4 spacecraft, such as the receive antenna gain, would preclude the further evolution of MSS satellite performance

  - Historically, improved satellite performance provides the following economic benefits
    - lower cost, or better performing, service
    - less expensive, smaller, earth terminals

  - Increasing demands for broadband communications require increasing amounts of bandwidth (a broadband data signal uses typically ten to twenty times the bandwidth of a digital voice signal) and more bandwidth-efficient modulation, which requires higher carrier to noise ratios, so interference will have a greater impact on system performance

  - Improved antenna performance supports
    - smaller spot beams
    - greater system capacity
    - increased spectrum reuse
    - smaller, more portable terminals

  - But improved receive antenna performance makes the system more sensitive to ATC interference.

  - The evolution of MSS spacecraft demonstrates how improvements in performance translate into these types of tangible economic benefits

- It is not feasible to retrofit existing Inmarsat mobile terminals in order to avoid the effects of ATC interference in Inmarsat's downlink band

  - over 250,000 Inmarsat terminals are already in service, deployed at a cost of thousands of dollars each.

  - it is not practical to recall and retrofit those terminals to enable them to reject ATC interference

Economic Impact on Inmarsat Users

- ATC deployment in the L-band would harm Inmarsat users
  - as set forth above, ATC would reduce the availability and quality of Inmarsat service to end users both within and outside the United States
  - many customers could lose access to a vital means of L-band communications on which they rely
    - Inmarsat is the only satellite system to meet stringent international quality-of-service standards for global maritime distress and safety system (GMDSS) and aeronautical safety services
    - Inmarsat is used by many commercial enterprises for essential business communications
      - media organizations
      - vehicle/vessel tracking and remote monitoring
      - communications on commercial aircraft and business jets
    - Inmarsat service is vital to many US defense and safety programs
      - The US Coast Guard and US Navy have Inmarsat terminals on many of their vessels
      - The Air Force 1 and Air Force 2 fleets are equipped with Inmarsat terminals that are vital to their missions, and the FAA relies on Inmarsat for air traffic control
      - Land mobile Inmarsat terminals are used for homeland security
    - some Inmarsat customers would have no alternative means of reliable communication if their Inmarsat service were disrupted
  - Inmarsat users have invested hundreds of millions of dollars in end-user equipment that has been optimized based on the existing allocations in the L-band, which do not provide for terrestrial services
    - allowing terrestrial use of the congested L-band changes those settled expectations